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Responses of meteorological parameters during August 24, 2016 Myanmar earthquake

Abhijit Ghosh[a,b*], Pranab Hazra[a], S S De[a], G Guha[a], Debasish Biswas[b]

[a]Centre for Advanced Study in Radio Physics and Electronics, University of Calcutta, Kolkata 700 009, India
[b]Department of Physics, Jadavpur University, Kolkata 700 032, India

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A continental plate movement in the Sunda Trench region resulted into the Myanmar Earthquake (M=6.8) of 24 August, 2016. The variations in the lithosphere–atmosphere-ionosphere (LAI) coupling take place during the occurrence of the earthquake. The thermodynamic equilibrium of the troposphere is very much connected with the atmospheric pressure, temperature, humidity, rainfall and wind speed. Some anomalies are observed on the surface temperature and other atmospheric parameters during the period. The anomalous surface latent heat increase takes place within a time interval of several days before a strong earthquake in this earthquake preparation zone. The variations in Lithosphere-Atmosphere-Ionosphere coupling during Myanmar earthquake (M=6.8) resulted in anomalous changes in different meteorological parameters. The variations in LAI may be due to enhanced radon and other greenhouse fluid emanations during the pre and post earthquake period. The meteorological data analyzed to investigate these observations as well as to invoke responses of the Myanmar earthquake. The occurrences of precursors during the pre-and post-periods of this earthquake from 1 August, 2016 to 30 August, 2016 are reported.

Keywords: Earthquake, Lithosphere-Atmosphere-Ionosphere coupling, Radon, Thermodynamic equilibrium, Greenhouse fluid.

1 Introduction

A huge amount of energy is released during an earthquake in the form of thermal, gravitational and emission of radiation. The release of strain through thermal energy and associated latent heat in the case of pressurized fluid are contained in the earthquake zone.

Myanmar Earthquake (M=6.8) of 24 August, 2016 resulted due to plate movements that introduce changes in coupling between lithosphere–atmosphere and ionosphere (LAI). There is strong relation between atmosphere-ionosphere disturbances and core structure of the Earth which involve radioactive gas emanations over the micro-fracture region of the earth[1,2]. This emitted radon gas ionizes the neutral particles which cause conductivity changes in air thereby modifying the atmospheric electric field. Apart from the radioactive radon, other greenhouse gases are also emanating from the Earth surface during pre and post-seismic periods which introduce changes in the meteorological parameters.

Abnormal enhancements of outgoing IR radiation above the seismo-active regions along the fault system of Earth's crust are observed in the thermal image taken from satellite[3-5]. Thermal anomalies are detected weeks before Earthquake and continued for a week or more with the increase in temperature of a few Kelvin and covering hundreds of km above the fault zone. The area of coverage depends on the magnitude of the earthquake and depth. The air temperature increased around the fault region by 3–4 K about ten days' pre- and post-earthquake. Thermal anomalies are recorded 4–7 days before and continued for about a few days after the earthquake M>6 and for distance of the order of 500 km[6, 7].

The LAI coupling model involving seismic processes could lead to atmospheric perturbations which could explain the origin of some preseismic electromagnetic effects in the ULF, VLF and HF frequency range[6-8]. The thermal balance of the boundary layer of the atmosphere gets affected through significant changes in humidity and temperature[2].

Thermal anomaly is an indicator for the seismo-atmospheric and seismo-ionospheric coupling[5,9,10]. The abnormality in the meteorological conditions like air humidity, temperature variations and air refractive index have been predominantly noticed in seismically active regions near the coast[11]. There exits a close relationship between the abnormal variations in air refractive index and ground-surface temperature[11].

*Corresponding author (E-mail: abhijit3034@gmail.com)

Different models of LAI coupling are proposed where the propagation of acoustic-gravity waves through atmosphere have been considered up to the ionospheric height before strong earthquakes. Some researchers attributed the ionospheric disturbances to the modifications of electric fields and currents in the lithospheric electric process[12].

The atmospheric oscillations through acoustic wave (AW or AGW) in the process of LAI coupling cause perturbations in surface temperature, humidity and pressure in a seismo-active region which finally travel up to the ionosphere enhancing density irregularities[13-15].

The investigations of the lithosphere-atmosphere-ionosphere thermal balance are connected with the observed density changes of the charged particles through satellites[16-19].

The fault between the Indian plate and Sunda Trench

The fault between the Indian plate and Sunda Trench is known as sagaing fault which is built at an intermediate depth of Indian plate and Sunda Trench, in Myanmar Earthquake. This fault cuts the centre of Myanmar in western and eastern half, one is moving towards north with the Indian plate and the other with the Eurasian plate, respectively. The Indian plate moves towards the northeast of Sunda Trench with a velocity of 44-49 mm/year. It is conjectured that the Himalayan Mountains are formed due to the uplift of the Tibetan plateau in the past of about 50 million years[20].

As sensitive plate boundary traverses Myanmar, large earthquakes were seen to initiate significant hazards. During the movements of the Indian plates into Eurasian plate[21], the eastern part of this plate slides obliquely sideways past south eastern Asia along a complex and diffused plate boundary (Fig. 1) beneath Myanmar[22]. The slanting motion is ripped into two components[23], e.g.

(i) East-directed plate convergence that uplifts in the Indo-Myanmar mountain ranges.
(ii) Strike-slip motion where India moves towards the north relative to the south eastern Asia.

Strike-slip is the sub-vertical slip between the plates (Fig. 2), which links these two different tectonic domains[24, 25]. These two tectonic domains are equally active and divided in a number of structures with the Sagaing Fault, as the significant one.

Fig. 1 — Coloured image shows the Myanmar as a south-east Asian country

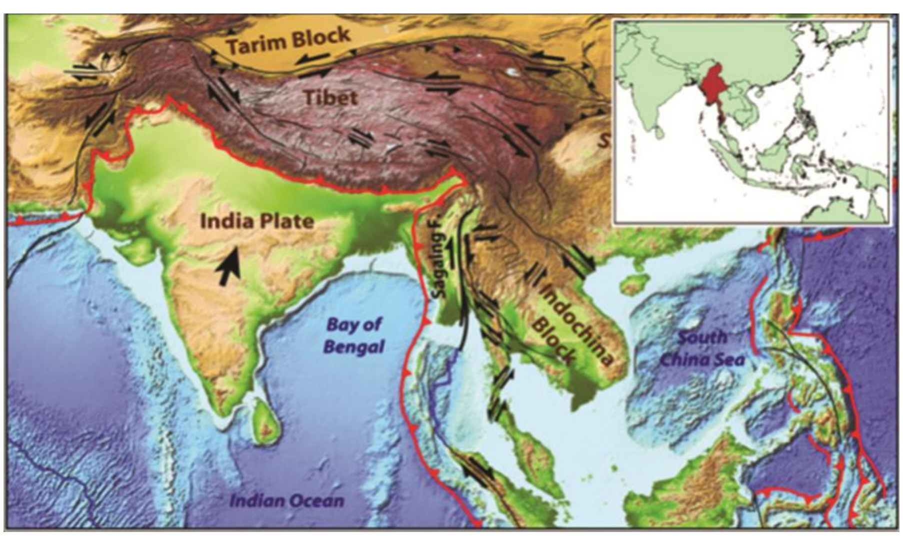

Fig. 2 — Tectonic map of Myanmar and its surroundings

Long tectonic fault in Myanmar and San Andreas Fault at San Francisco

In Myanmar, 1500 km long tectonic fault passes through cities like Bago, Nay Pyi, Sagaing and Madalay (Fig. 3). The other type of strike-slip fault on Earth is the San Andreas Fault in the western USA. Both these faults are passing through highly populated and rapidly developing cities. These two faults are almost similar except the average slip rate per year. The sagaing Fault slips at an average rate of 18-20 mm/year[22], while the San Andreas Fault at San Francisco is about 24±3 mm/year[26].

These faults remain locked for many years until enough stress is built to overcome friction on the fault. An earthquake releases all these stresses, and the sides of the fault slide a few decimeter to meters past each other, depending on how much time has elapsed since the last earthquake (stick-slip behaviour). There are two conspicuous seismic gaps along the Sagaing Fault where there were no historical earthquake greater than M=7[27]

2 Observations and analysis

Thermal anomalies have a greater impact on the atmosphere a few days before the earthquake. The changes due to the thermal anomalies can be observed on the surface temperature, and upon other atmospheric parameters. The troposphere in thermodynamic equilibrium is a complex system of interrelated atmospheric temperature and humidity. Another important parameter is the latent heat which is closely related with the water content in the air and the processes of water evaporation. In the earthquake preparation zone, the anomalous surface latent heat increase takes place within a time interval of several days before a strong earthquake.

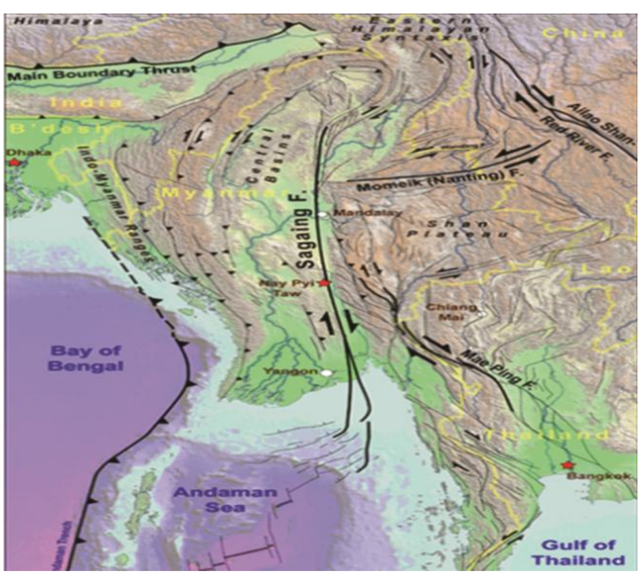

Fig. 3 — 1500 km long tectonic fault in Myanmar and surrounding areas

The thermodynamics of the lower atmospheric layers are manifested by the action of the ionization source and strong electric fields which are supposed to be the most probable sources of observed thermal and surface latent heat flux anomalies before strong earthquakes[2].

The coupling processes among Lithosphere-Atmosphere-Ionosphere layers through electromagnetic channel and the acoustic channel during the Myanmar earthquake with M=6.8 on 24 August, 2016 is depicted through the variations of different meteorological parameters like temperature, humidity, pressure that may be caused by the enhanced radon emanations along with some other diffused inputs due to the venting of carrier gases from the sub-surface (Fig. 4, (a–h)).

Here the satellite data were analyzed to investigate the variations of temperature, humidity and other atmospheric parameters and ionospheric responses during the Myanmar earthquakes. The data of ionospheric variability, air temperature and relative humidity were taken from Chauk Historical Weather, Myanmar ground stations (http://www.world weatheronline.com/chauk-weather-history/). The daily temperature as well as humidity variations during the pre-and post periods of this earthquake from 1 August, 2016 to 30 August, 2016 is shown in figure 4 at Chauk recording stations at Myanmar. Relative humidity variations to minimum and maximum value of the order of 15% and temperature were between 24 ºC -31 ºC during this period.

The relation of air temperature and pressure was inversely related although contradict with their nature Fig. 5. The maximum temperature and pressure variation was started to follow the same pattern 3-4 days before. The variation in wind speed with maximum temperature was found to start 6 days before large earthquakes in Myanmar on 24 August 2016, (fig. 6). The variations of maximum temperature and wind speed for the region of occurrences of the earthquake station, namely Chauk, Myanmar, showed ample variation, but during the earthquake it followed some common trend. The noticeable correlation of humidity and rainfall with the occurrence of the earthquake is depicted in Fig. 7 on the earthquake day.

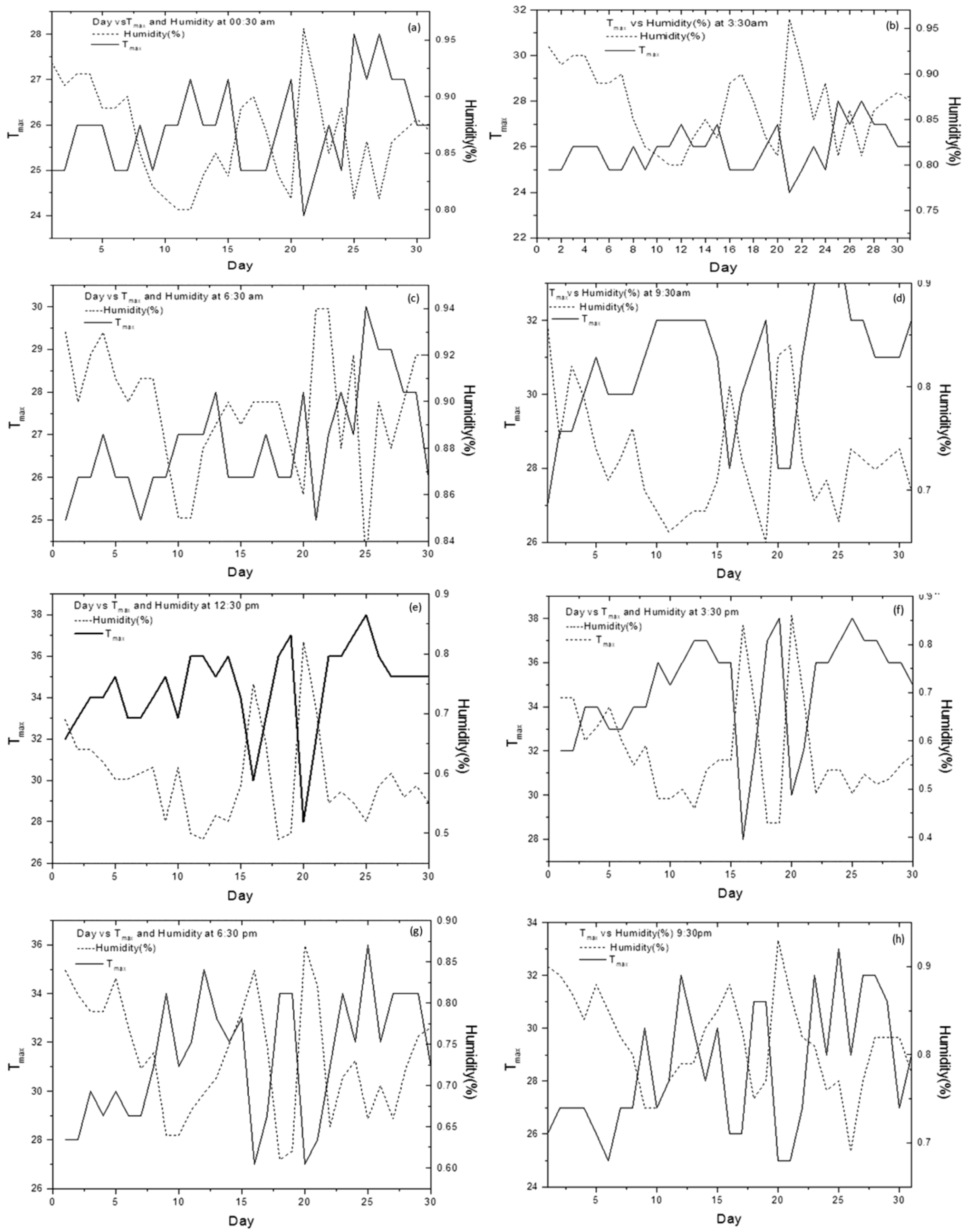

Fig. 4 — Thirty days daily maximum temperature and relative humidity range variations registered for the Myanmar earthquake; Figure a to h depicts the inverse relation of these two meteorological parameters which becomes significant 4-5 days before the main shock

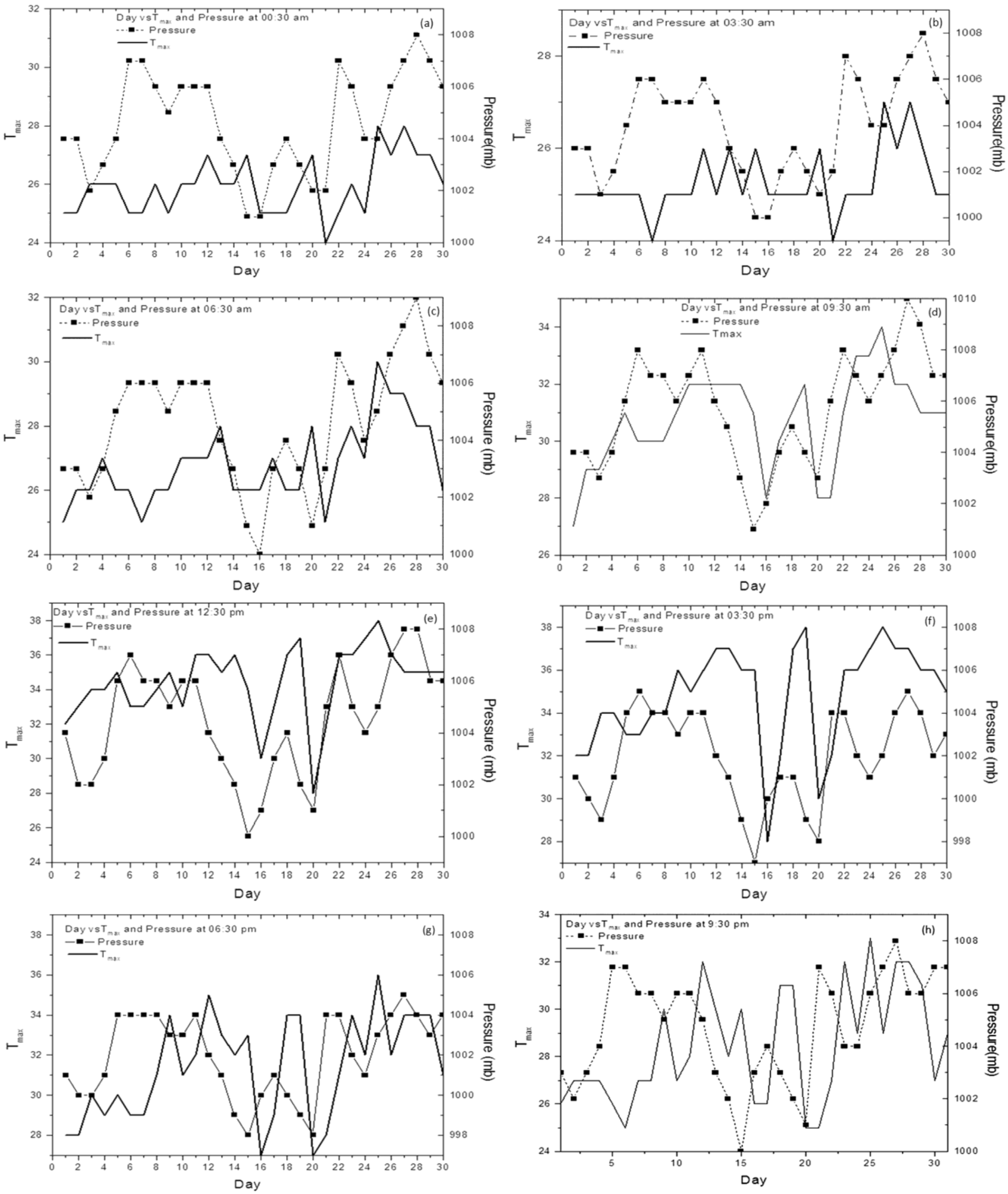

Fig. 5 — Variations of air pressure and maximum temperature for a period of 30 days before and after the Myanmar earthquake are depicted for different time of the day through figure (a) to (h). These show the extent of maximum air pressure about 1008 mb, which is reasonably higher than the normal value

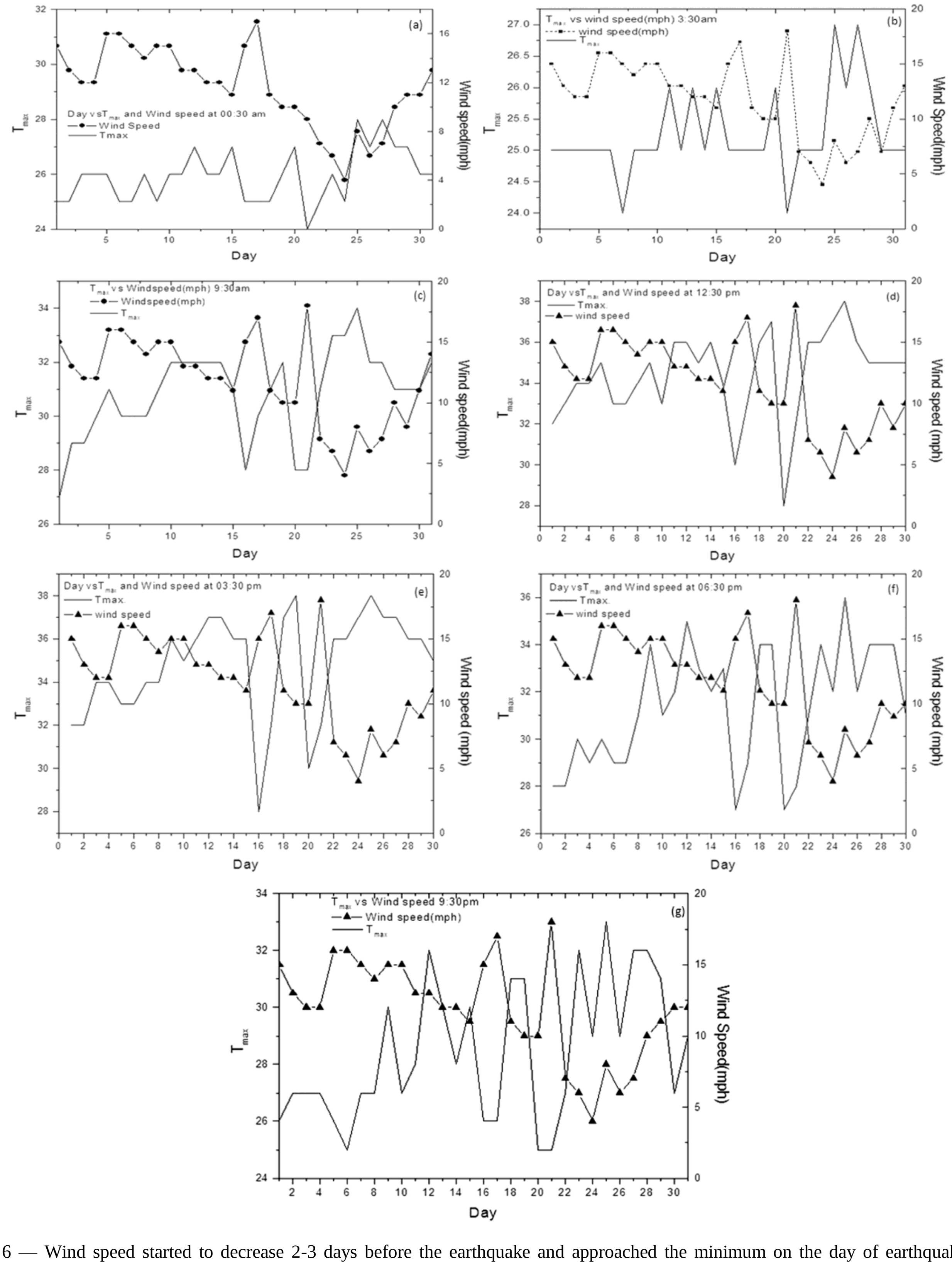

Fig. 6 — Wind speed started to decrease 2-3 days before the earthquake and approached the minimum on the day of earthquake as depicted through a to h

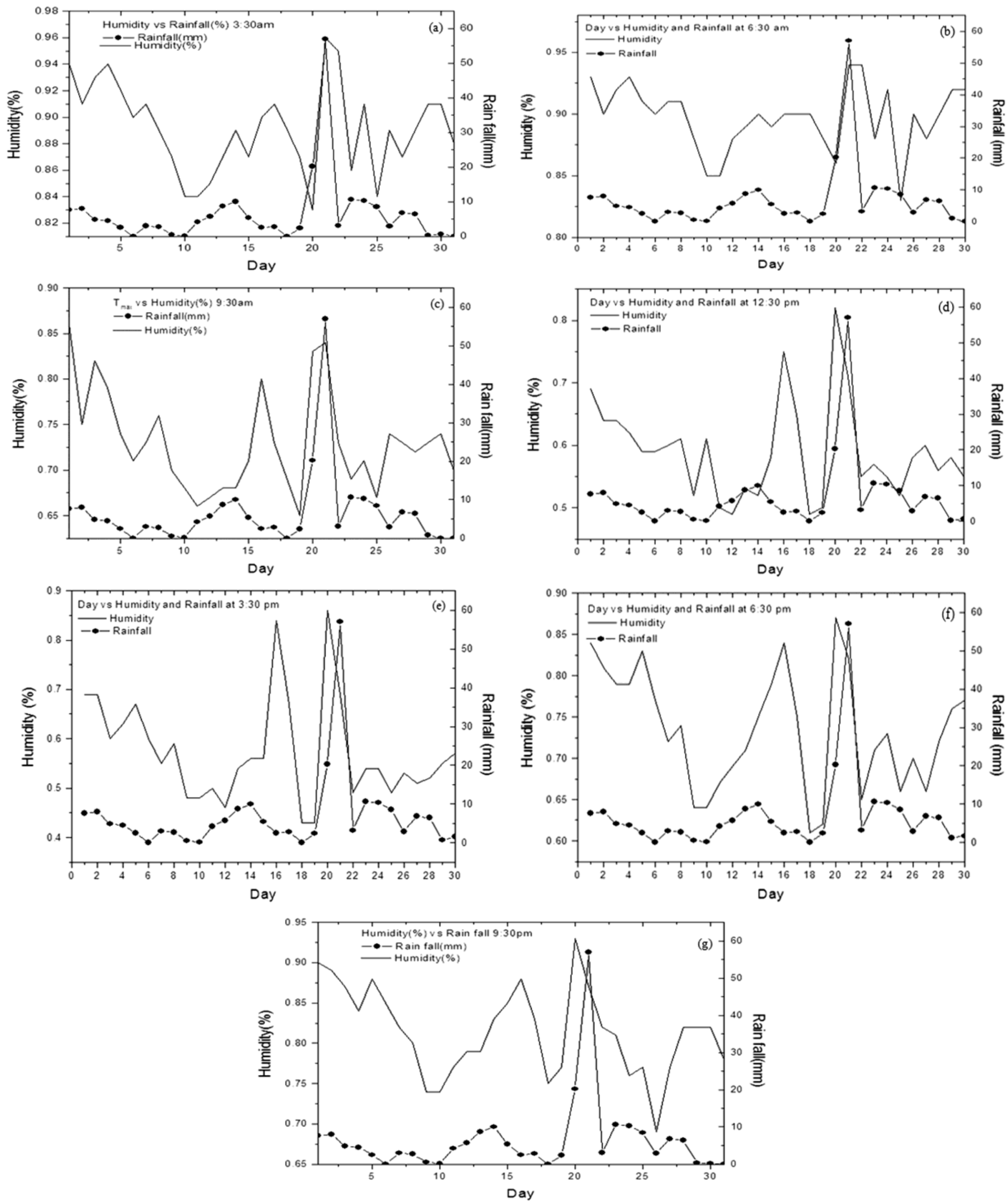

Fig. 7 — The figures presented here are indicating the meteorological parameter variations of rainfall & relative humidity both reaches the highest value almost 2 days before the earthquake. The variations of meteorological parameters, rainfall & relative humidity almost follow the similar trend

3 Conclusion

The responses upon some meteorological parameters of Mayanmer Earthquake of 24 August 2016 are presented in this paper. The data from the Chauk Historical Weather, Myanmar ground stations (http:// www.worldweatheronline.com/chauk-weather-history/) are used in the study. The responses are caused by the co-ordinated interactions in the geophysical processes within the Lithisphere-Atmosphere-Inosphere system. The anomaly in the meteorological conditions- humidity, temperature, pressure and wind speed predominantly noticed near the Mayanmer Earthquake Zone. The changes are also attributed to the anomalous surface latent heat increase several days before the earthquake. The observed variations may be attributed to the enhancement of radon and other green house fluids during the occurrence of this earthquake. Our results of the observed thermal effects surrounding the tectonic plates are also in line with the observations made by other researchers in this field.

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References

1 Shaftan V A, Zlotnikov M F, Vinogradov J I & Tchigin E P, *Magnetospheric Investigations,* 8 (1986) 126.
2 Pulinets S A & Dunajecka M A, Tectonophys , 431 (2007) 221
3 Tronin A A, , Terra Scientific Publishing Company, (1999) 717.
4 Tramutoli V, Belio D, Pergola G N & Piscitelli S, *Annali di Geofisica,* 44 (2001) 295.
5 Tronin A A, Hayakawa M & Molchanov O A, J Geodyn, 33 (2002) 519
6 Tronin A A, Biagi P F, Molchanov O A, Khatkevich Y M & Gordeeev E I, Phys Chem Earth, 29 (2004a) 501.
7 Tronin A A, Molchanov O A & Biagi P F, *Int* J Rem Sens, 25 (2004b) 2649.
8 Ouzounov D, Pulinets S, Tramutoli V, Liu T, Hattori K, Parrot M, Namgaladze A & Solomentsev D, *URSI GASS,* (2014) 1.
9 Hayakawa M & Molchanov O A, TERRAPUB, (2002).
10 Dey S & Singh R P, *Nat Hazards Earth Syst Sci,* 3 (2003) 749.
11 Hayakawa M, VLF, Sensors, 7 (2007) 1141.
12 Liperovsky V A, Pokhotelov O A, Meister C V & Liperovskaya E V, *Geomag Aeron,* 48 (2007) 795.
13 Molchanov O A, Hayakawa M & Miyaki K, *Adv Polar Upper Atmos Res,* 15 (2001) 146.
14 Miyaki K, Hayakawa M & Molchanov O A, TERRAPUB (2002) 229.
15 Hayakawa M, Raulin J P, Kasahara Y, Bertoni F C P, Hobara Y & Guevara-Day W, *Nat Hazards Earth Syst Sci,* 11 (2011) 513.
16 Gokhberg M B, Pilipenko V A & Pokhotelov O A, *Doklady AN SSSR,* 268 (1982) 56.
17 Gokhberg M B, Pilipenko V A & Pokhotelov O A, *Izv. AN SSSR, Fizika Zemli,* 10 (1983) 17.
18 Migulin V V, Larkina V I, Liperovsky V A, Molchanov O A, Nalivaiko A V, Gokhberg M B, Pilipenko V A, Pokhotelov O A & Shalimov S L, *IZMIRAN AS USSR,* Preprint No. 25a (1982).
19 Larkina V I, Nalivaiko A V, Gershenson N I, Liperovsky V A, Gokhberg M B & Shalimov S L, *Geomag Aeron,* 23 (1983) 842.
20 Yin A, Dubey C S, Kelty T K, Gehrels G E, Chou C Y, Grove M & Lovera O, *Curr Sci,* 90 (2006) 195.
21 Socquet A, Vigny C, Chamot-Rooke N, Simons W, Rangin C & Ambrosius B, *J Geophys Res,* 111 (2006) 1.
22 Vigny C, Socquet A, Rangin C, Chamot-Rooke N, Pubellier M, Marie-Noe, Bouin L, Bertrand G & Becker M, *J Geophys Res,* 8 (2003) 2533.
23 Nielsen C, Chamot-Rooke N, Rangin C & the ANDAMAN Cruise Team, *Marine Geol,* 209 (2004) 303.
24 Curray J R, *J Asian Earth Sci,* 25 (2005) 187.
25 Searle M P & Morley C K, *Tectonic and Thermal Evolution of Thailand,* (2011) 539.
26 Niemi T M & Hall N T, *Geol,* 20 (1992) 195.
27 Hurukawa N & Maung P M, *Geophys Res Lett,* 38 (2011) 1.